LIBRARIES OF THE FUTURE

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The Role of Schemata

Freedom from constraints imposed by existing concepts and devices, however, is double-edged. According to the most advanced theories of cognition, men think by manipulating, modifying, and combining "schemata." A new concept is achieved, not by creating a new schema *ab initio,* on a custom basis, but by adapting an old schema or, if necessary, arranging several refurbished schemata into a new, complex structure. If we renounce schemata derived from experience with existing library systems, file rooms, and computer centers, therefore, we have to be careful not to leave ourselves without parts from which to construct new concepts. A guideline for avoiding that predicament is to discard the upper-echelon schemata — those at the level of system and subsystem — and to retain, for possible alteration and reuse, the lower-echelon, component-level schemata.

It is not possible, in a summary report, to present a complete inventory of promising component-level schemata, but it may be helpful to illustrate the idea of discarding schemata at the system and subsystem levels while retaining those at the component level. The illustration will take the form of comments about pages (components), books (subsystems), and libraries (systems).

Pages, Books, and Libraries

As a medium for the display of information, the printed page is superb. It affords enough resolution to meet the eye's demand. It presents enough information to occupy the reader for a convenient quantum of time. It offers great flexibility of font and format. It lets the reader control the mode and rate of inspection. It is small, light, movable, cuttable, clippable, pastable, replicable, disposable, and inexpensive. Those positive attributes all relate, as indicated, to the display function. The tallies that could be made for the storage, organization, and retrieval functions are less favorable.

When printed pages are bound together to make books or journals, many of the display features of the individual pages are diminished or destroyed. Books are bulky and heavy. They contain much more information than the reader can apprehend at any given moment, and the excess often hides the part he wants to see. Books are too expensive for universal private ownership, and they circulate too slowly to permit the development of an efficient public utility. Thus, except for use in consecutive reading — which is not the modal application in the domain of our study — books are not very good display devices. In fulfilling the storage function, they are only fair. With respect to retrievability they are poor. And when it comes to organizing the body of knowledge, or even to indexing and abstracting it, books by themselves make no active contribution at all.

If books are intrinsically less than satisfactory for the storage, organization, retrieval, and display of information, then libraries of books are bound to be less than satisfactory also. We may seek out inefficiencies in the organization of libraries, but the fundamental problem is not to be solved solely by improving library organization at the system level. Indeed, if human interaction with the body of knowledge is conceived of as a dynamic process involving repeated examinations and intercomparisons of very many small and scattered parts, then any concept of a library that begins with books on shelves is sure to encounter trouble. Surveying a million books on ten thousand shelves, one might suppose that the difficulty is basically logistic, that it derives from the gross physical arrangement. In part, of course, that is true, but in much greater part the trouble stems from what we may call the "passiveness" of the printed page. When information is stored in books, there is no practical way to transfer the information from the store to the user without physically moving the book or the reader or both. Moreover, there is no way to determine prescribed functions of descriptively specified informational arguments within the books without asking the reader to carry out all the necessary operations himself.

We are so inured to the passiveness of pages and books that we tend to shrug and ask, "Do you suggest that the document read its own print?" Surely, however, the difficulty of separating the information in books from the pages, and the absence, in books, of active processors, are the roots of the most serious shortcomings of our present system for interacting with the body of recorded knowledge. We need to substitute for the book a device that will make it easy to transmit information without transporting material, and that will not only present information to people but also process it for them, following procedures they specify, apply, monitor, and, if necessary, revise and reapply. To provide those services, a meld of library and computer is evidently required.

1. Random-access memory,
2. Content-addressable memory,
3. Parallel processing,
4. Cathode-ray-oscilloscope displays and light pens,
5. Procedures, subroutines, and related components of computer programs,
6. Hierarchical and recursive program structures,
7. List structures,
8. Procedure-oriented and problem-oriented languages,
9. Xerographic output units,
10. Time-sharing computer systems with remote user stations.

Criteria for Procognitive Systems

The criteria that are clearly within our scope are those that pertain to the needs and desires of users. The main criteria in that group appear to be that the procognitive system:

1. Be available when and where needed.
2. Handle both documents and facts.*
3. Permit several different categories of input, ranging from authority-approved formal contributions (e.g., papers accepted by recognized journals) to informal notes and comments.

7. Converse or negotiate with the user while he formulates his requests and while responding to them.
8. Adjust itself to the level of sophistication of the individual user, providing terse, streamlined modes for experienced users working in their fields of expertness, and functioning as a teaching machine to guide and improve the efforts of neophytes.
9. Permit users to deal either with metainformation (through which they can work "at arms length" with substantive information), or with substantive information (directly), or with both at once.

Among the functions provided by Symbiont are the following:

1. Present for examination a document specified by any sufficiently prescriptive segment of its bibliographic citation.
2. Turn pages, forward or backward, in response to the pressing of a key.
3. Permit designation of a passage (segment of text) by pointing to the beginning and then the end with a light pen.
4. Accept labels from the typewriter and associate them with passages of text.
5. Record as a note, and preserve for later inspection, any designated passage.
6. Append bibliographic citations to extracted passages.

7. Accept retrieval prescriptions from the typewriter.

8. Accept from the typewriter coded versions of specifications of such operating characteristics as, "Consider a neighborhood to be five consecutive lines of text," or "Consider a search to be satisfied when any two of the three elements of the search have been satisfied."

9. Carry out retrieval searches and display passages in which the retrieval prescriptions are satisfied.

10. Compose graphs from tabulated data and present the graphs, against labeled coordinate grids, on the oscilloscope screen.

11. Set two graphs side by side to facilitate comparison.

12. Expand or compress the scales of graphs, under control from the light pen.

13. Change the number of grid lines or the calibration numbers associated with the lines, or both together, and recalculate and redisplay the calibration numbers when grid lines are added or deleted.

Symbiont is used like this: At the beginning of his study session, the student inserts in the computer memory representations of the documents he plans to study. Then, typically, he calls for a document and reads or scans it. He calls for it by typing any part of the standard bibliographic citation that specifies it uniquely.

The first page is displayed on the screen — the student turns pages in the forward direction by hitting the typewriter space bar, and in the backward direction by hitting the backspace key.